Space Weather Technical Forecast

Issued on Wednesday, 04 October 2023 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares throughout. Slight chance of isolated G1/Minor Storm intervals on day 3 (6th Oct).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Low, with a peak flare of C3.5 at 03/1703 UTC from AR3450. There are currently eight sunspot regions on the visible disc, the largest and most magnetically complex is AR3452 (Eai/Beta) in the northeast. There continues to be the emergence of small intermediate spots from this region, with bifurcation of these as they develop, indicating some magnetic shear. A number of regions, AR3448, 3450, 3451 and 3453 have seen their trailer spots fade during the period with little, or no penumbra evident, resulting in a simplification of their classification. AR3449 in the northwest has faded, as has AR3455 in the northeast, as well as an unnumbered region in the far northwest. AR3456 has emerged as a small bipolar group in the southwest. All other regions are small and/or simple at this time.

No new Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, were at background levels, generally between 340-380 km/s. Density was largely below average. The interplanetary magnetic field (IMF), Bt, was largely weak, but increased through the evening of 03 Oct to reach predominantly moderate levels around 8nT. The north-south component, Bz, was weak throughout, between +4nT and -7nT. Phi angle was largely positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electrons were predominantly at Background to Moderate levels, but briefly reached High levels at the peak of the diurnal cycle, peaking at 1297 pfu at 03/1540 UTC. Associated 24-hour fluence was below Active (1e8 integrated pfu) threshold. The observation at 04/0000 UTC was 2.12e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Mainly Low activity is expected but with a chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: After some reanalysis, a fairly slow CME from 02 Oct in the vicinity of AR3540 has been assessed as being Earth-directed, with an expected arrival early on day 3 (06 Oct). Otherwise, no other CMEs feature in the forecast. The fast wind associated with an equatorial coronal hole in the western hemisphere has still not manifested at Earth. It now appears unlikely to connect significantly, meaning that largely background winds are expected through the period, with no significant high-speed stream enhancements forecast.

Mainly Quiet geomagnetic activity is expected with isolated Unsettled intervals through days 1 and 2 (04 and 05 Oct), with just a slight chance of Active conditions. Activity should increase to become mainly Unsettled or Active during day 3 (06 Oct) following the arrival of the

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

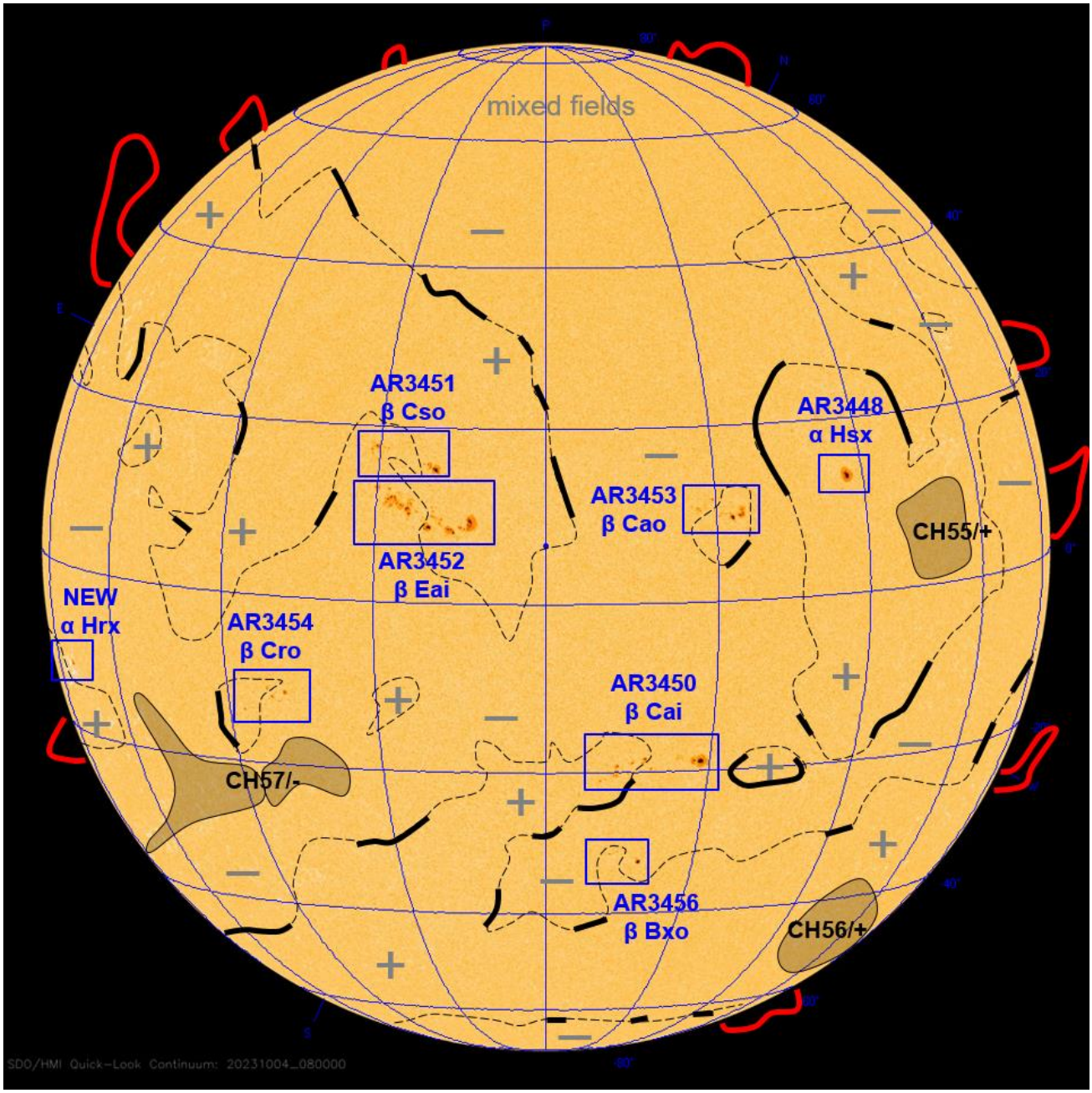
aforementioned CME from 02 Oct. There is a slight chance of G1 Minor Storm conditions occurring with this feature. Activity likely reducing to Quiet to Unsettled levels again on day 4 (07 Oct).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels, with no Solar Radiation storms expected. High energy electron flux (greater than 2MeV) observed by GOES16 is forecast to vary between mainly background and Moderate levels, with the potential to reach High levels at the peak of the diurnal cycle on day 2 (05 Oct) and perhaps day 3 (06 Oct). Electron counts should become largely background to Moderate again during day 3 and 4 (06 and 07 Oct), resulting from increased geomagnetic activity associated with the 02 Oct CME. Fluence is forecast to remain below the Active (above 1e8 integrated pfu) threshold throughout.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 1. Solar Analysis Valid 04/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A coronal dimming from 02 Oct associated with a C-class flare and small eruption from AR3450 seen starting at 02/1554 UTC has been reanalysed and considered to have resulted in a faint, rather slow Earth-directed CME. Estimates are for an arrival at Earth early on Day 3 (06 Oct), although confidence in timings is medium. Otherwise, no other CMEs feature in the forecast.

The fast wind associated with equatorial CH55/+ has still not manifested at Earth, in contrast to Enlil's expectations. It now appears unlikely to connect significantly, meaning that largely background winds are expected through the period, with no significant high-speed stream enhancements forecast.

Mainly Quiet geomagnetic activity is expected with isolated Unsettled intervals through days 1 and 2 (04 and 05 Oct), with just a slight chance of Active conditions. Activity should increase to become mainly Unsettled or Active during day 3 (06 Oct) following the arrival of the aforementioned CME from 02 Oct. There is a slight chance of G1 Minor Storm conditions occurring with this feature. Activity likely reducing to Quiet to Unsettled levels again on day 4 (07 Oct).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	15	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

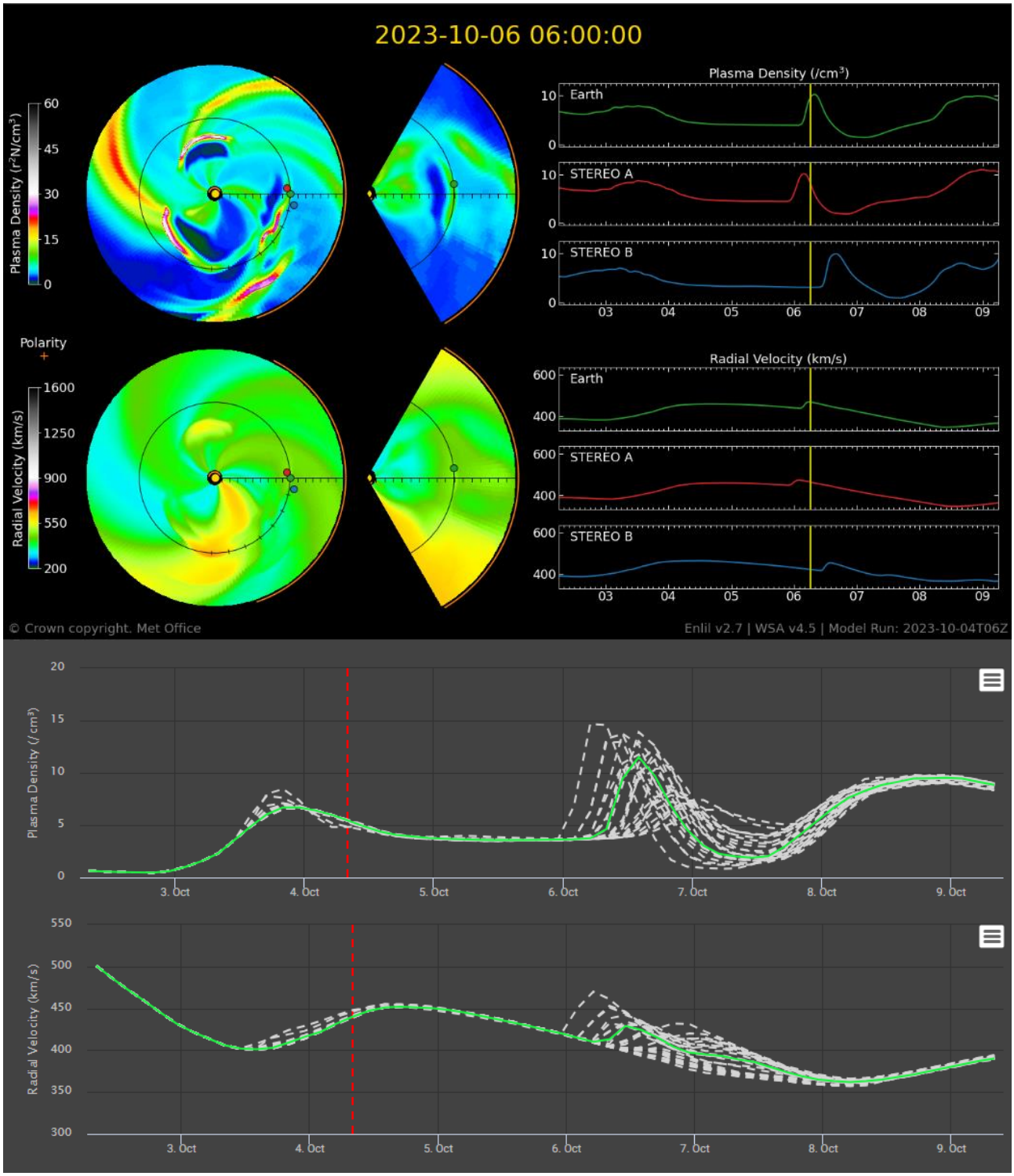
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/0108	Partial	AR3450	South centre-disc	445km/s	06/0600 UTC	Medium-high confidence on arrival. Medium confidence for exact timing.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2: Latest MOSWOC Enlil output (above). Time set at 06/0600 UTC, estimated arrival time of 02 Oct CME. Enlil Ensemble output (below)



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:

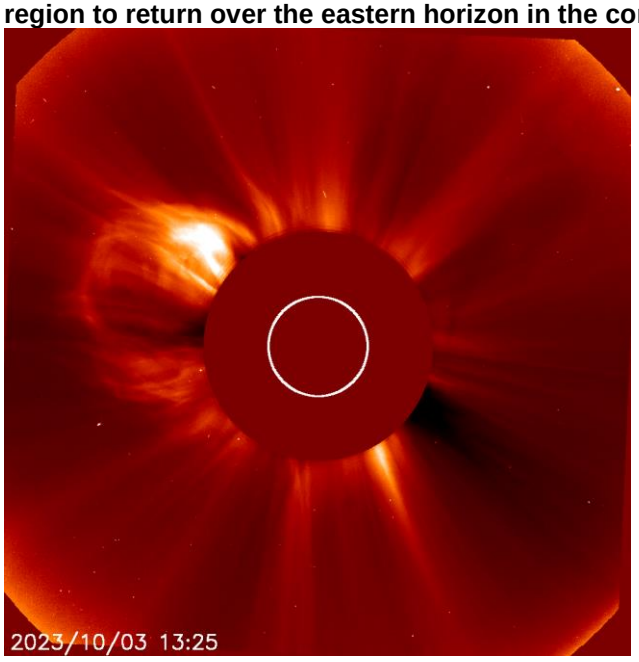
There are currently eight sunspot regions on the visible disc, with AR3449 having decayed and the previously new region in the northwest now faded to plage. The largest and most magnetically complex is AR3452 in the northeast. There continues to be the emergence of small intermediate spots, with bifurcation of these as they develop, indicating some magnetic shear. A number of regions, AR3448, 3450, 3451 and 3453 have seen their trailer spots fade with little, or no penumbra evident, resulting in a simplification of their classification. All other regions are small and/or simple at this time.

Seismic signatures of the sun's far-side suggest that a number of active regions may rotate onto the Earth-facing disc during the period. These could include a number of returning regions that left the visible disc around a fortnight ago. Recent CME activity suggests that one or more of these regions could still be active and could influence the flare probabilities in the coming days.

Mainly Low activity is forecast to continue, with a chance of isolated M-flares, these most likely from AR3450 or AR3452.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: SOHO LASCO C2 imagery at 03/1325 UTC. Large far-sided CME likely associated with active region to return over the eastern horizon in the coming days



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels, with the current sunspots on the disc unlikely to produce proton rich flares.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	2	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16, is currently at background to Moderate levels. Should the delayed high-speed stream from CH55/+ arrive later today (04 Oct), then a recovery in flux is then probable from later tomorrow (05 Oct), perhaps increasing to Moderate levels with a chance of peaking at High during diurnal maximum. Any increase should be short-lived though, as the 02 Oct CME is forecast to arrive at Earth, with a subsequent dropout of electrons on day 3 (06 Oct), largely continuing into day 4 (07 Oct).

The associated 24 fluence is expected to remain below the Active threshold throughout the period. REFM forecasts appear to be giving good guidance at this time.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 4: GOES 16 >2MeV Electron flux in the past 24 hours (above) and Electron Fluence with MOSWOC forecast and Recurrence (below)

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.